A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

VOLUME III
NUMBER 3
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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information for teachers of science in the Catholic high schools. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

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Volume III SEPTEMBER, 1937 No. 3

CONTENTS

THE NEW YEAR 65

THE CATHOLIC HIGH SCHOOL AND SCIENTIFIC RESEARCH 67
Reverend John M. Cooper

DOUBLE LABORATORY PERIODS IN HIGH SCHOOL CHEMISTRY 69
Edward E. Wildman

SCIENCE IN THE PROFESSIONAL EDUCATION OF TEACHERS FOR THE ELEMENTARY SCHOOL 70
Helen Heffernan

MY SCIENCE CLUB HAS PROBLEMS, TOO 72
Charles M. Eddy

THIS IS STATION HJV 73
Raymond E. Vecchio
Reverend James McVann

THE SCHOLASTIC CLASSIFICATION OF THE SCIENCES 75
Reverend James F. Carroll

THEORIES OF ELECTROLYTIC SOLUTIONS 77
Sister Mary Dorcas Smith

IMPORTANT DISCOVERIES MADE AT THE INSTITUTUM DIVI THOMAE 79

BOOK REVIEWS 81

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A new school year begins.

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One who instructs the young assumes grave responsibilities. He should understand and appreciate them. He must be well prepared for the work he is to do. He should have breadth of background as well as special information in his own field. He must keep up-to-date in his technical information and in his teaching methods. The teacher of science, especially, must be progressive, alert and inspiring.

Through additional college courses and special lectures, through reading current scientific journals and the newest and best books in science and education, by conferences with other teachers in his field, by constant experimenting in his own classroom and laboratory—even though it be only simple experimenting—the teacher may renew his enthusiasm, bring his information up-to-date, and improve his teaching methods.

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The Catholic High School
And Scientific Research

● **By Rev. John M. Cooper, S.T.D., Ph.D.,** *(American College, Rome)*
PROFESSOR OF ANTHROPOLOGY, THE CATHOLIC UNIVERSITY OF AMERICA

In Catholic academic circles just now scientific research is a live topic for discussion. Many high school teachers are interested but they know little of the factors involved.

What constitutes true research? Why should we be concerned about it? What can high school teachers do?

Father Cooper, one of the founders of the important Catholic Round Table of Science, discusses the question of scientific research in general as well as from the Catholic viewpoint. His paper contains the substance of an address delivered by him before the recent Duquesne University Conference for teachers of science in Catholic high schools.

●

In the space at our disposal we shall try to answer briefly three questions. First, What is scientific research? Second, Why should we as Catholics take part in it? Third, What can the high school do to promote it?

Scientific research may be described as investigation undertaken to make new contributions to science. Research aims to discover either new basic facts or else new relations between facts already known. Ordinarily these facts or relations are of the positive and affirmative order. But a critical study resulting in the correction of errors would also be a new scientific discovery, of the negative order. Likewise the invention of a new scientific method or technique comes well within the technical meaning of a contribution to science.

It is always understood that the new fact has some bearing on larger problems. If I were to count the needles on fifty spruce trees to discover whether the number of needles on each is an even or uneven one, my discovery would be a new fact, but not a fact of any conceivable value to botany or to any other discipline. On the other hand we can seldom make sure that a new fact, however trivial it appears, may not have real value. To his dying day, Mendel did not seem to realize the vast significance of his experiments in his cloister garden at Brünn, nor did the scientific world realize their significance until the dawn of the present century, thirty-five years after their publication in 1865.

So much for what is ordinarily understood by scientific research. We may turn for a moment to certain activities which are sometimes called research in a very loose sense, but which do not actually constitute research as the word is and should be used and understood. If I have to prepare a paper or a lecture on a subject with which I am not very familiar, I may have to do a good deal of digging in first-hand or in second-hand sources in order to find out what others have already discovered about the subject. I may devote a month of hard work to this task and may require knowledge of a great many facts and relations between facts that had hitherto been unknown to me. But these facts and relations were already known to others, and through publication had already been contributed to science. My digging to prepare the paper or the lecture would not therefore constitute research.

Again, should I make a compilation of all that is known on a given subject, this would not be research, even though such a compilation had never been made by anyone else. For in this case I would not be discovering any new facts or any new relations between facts. I would merely be assembling and putting in order what had previously been discovered. It goes without saying that a translation of an existing work in an Indo-European language into English does not, as such, constitute research. Nor, ordinarily, is the writing of a textbook correctly called research, unless the textbook happens to embody new data which have been discovered by the author thereof.

Since the purpose of research is to make new contributions to science, not only must the data be new but they must be contributed to the scientific world. In other words, the results of research must be made accessible to scientific workers. Ordinarily this means that the results of research must be published, else these results do not constitute a contribution to science. If a man makes discoveries of a scientific nature and keeps the discoveries to himself, he has carried out the first step in research, he has done research, but he has not made a contribution to science. Likewise, if he makes public the results of his study only orally in classes or lectures, this is hardly sufficient. In this case the results are made accessible to his limited group of hearers, but these are only an infinitesimal fraction of the scientific world.

Results of research may be presented to the scientific world either in books, in brochures, or in articles. They need not necessarily be printed. In fact, owing to the high expense of printing, more and more is the scientific world resorting to cheaper processes of publication, especially photolithographic processes. And just within the last half decade a new device of "publishing," by microfilm, is opening up a broad boulevard that may help appreciably to break the publication jam that is at present so badly holding up scientific traffic.

Let us come to our second question: Why should we as Catholics do our part in scientific research?

There are many reasons, reasons of principle and reasons of policy.

We of the present generation have received knowledge generously from the past. As we have received, so it becomes us to give as best we may. It is our task not only to keep alight the torch of knowledge that the past has put in our hands, but as well to kindle new fires with it.

There are other reasons of principle which should appeal to us particularly as Catholics dedicated by our faith to love of God and to love of man.

All truth comes from the God of truth. We learn to know and love God not only in His words but also in His works. Scientific research, as a Catholic carries it out, is a study of the book of God's works. Each new discovery gives us wider and deeper knowledge of the Divine Worker as seen in His works, and makes it just a little easier to realize His wisdom, His power, and His goodness. To give just one illustration, our ancestors of scores of generations ago could indeed look up at the sky and realize something of the majesty of God. But what a miniature sky, a veritable doll's house, they looked at. The amazing discoveries of modern astronomy, opening vistas into star-studded spaces that can be measured only by thousands of light-years, have given us a new vision of the majesty and glory of Him Who holds the universe in the hollow of His hand.

It is research that has given us modern knowledge. It is true that this modern knowledge has built a mechanical civilization which we have not learned to master. The machine is in the saddle and rides mankind. But there is another side to the picture. Science has been a providential helpmate of Christianity in helping her carry out the works of mercy. Every hospital in the land is a witness to this truth. And there are other witnesses by the legion.

Further, religion and science, working each in its own way, have largely banished the mass of superstitions that have been the perennial bane of the race. Superstitions dishonor God. We often forget, however, that they are the deadliest enemy of man himself and of man's welfare. A very strong case can be made from one science alone, ethnology, for the generalization that superstitions have done more harm to man than have those three grisly servitors of Azrael combined,—war, pestilence and famine. For many a long century the Church fought the battle alone. In these latter days she has won a valiant recruit in science. The campaign is not over by any means. But at least the dark battalions of superstition are in rout.

Not only as a matter of principle but also as a matter of policy is it our responsibility as Catholics to take our fair part in research. Both for the honor of the Catholic name and for the success of our higher educational system, and for that matter of our whole educational system,—because the higher and the lower stand or fall together,—we as Catholics must have our status in the world of science, learning and scholarship. And we must have it today and tomorrow. It is futile and worse than futile to rest our claims on our Catholic scientific past. Of three great scientists, perhaps the greatest, which the nineteenth century produced,—Pasteur, Mendel, Darwin,—two were Catholics and we are proud of them. But all three have long been dead. And we cannot build our present-day status on dead men's bones, however distinguished the men to whom these bones belonged. The scientific world challenges us and challenges us rightly, not with the question, "What did your ancestors do?", but with the more searching one, "What are you doing today and what are you preparing yourselves to do tomorrow?"

Are we as Catholics doing our proportional part in scientific research in the United States today? Would that we could answer yes. But we cannot honestly do so. May I illustrate from the scientific discipline in which I happen to be most interested personally, that of anthropology? There are between four hundred and four hundred and fifty men and women in the United States today who are looked upon as professional anthropologists. Among those who rank as the first twenty-five in eminence, not one to my knowledge is a Catholic, and my work has brought me into fairly intimate personal as well as professional relations with them. Of the first one hundred or one hundred and fifty in rank of eminence, not five are Catholics. Yet we as Catholics constitute something like twenty per cent of the total population of the United States. Dr. Karl Herzfeld presented several years ago somewhat similar figures for Catholic ranking among American physicists. The figures and percentages in most, and perhaps in all other scientific disciplines, are probably not appreciably different.

There are excellent reasons to account for all this and to exculpate us. For a whole century up to the passing of our restrictive immigration laws a decade and a half ago, the Catholics of the United States had to devote their full resources of personnel and finance to meet the gigantic task thrust upon them by unprecedented mass immigration. We have no apologies to make either to the American people or to our Catholic colleagues in Europe for the manner in which our American Catholic ancestors, clergy and laity working together, achieved that task. It was a titanic job. It was magnificently done. But mass immigration is with us no more. The brick-and-mortar period has passed into history. The emergency is over or largely so. Now we are free to put our hands to some of the secondary but important tasks that still remain to be done. One of these is certainly that of playing our fair part as Catholics in scientific research.

We now come to our third and last question: How can the high school help? Naturally the major part of the responsibility rests on our Catholic colleges and still more on our Catholic graduate schools. But neither the college nor the graduate school here concerns us. We are thinking now only of the high school. Both students and staff are involved, although the initiative will of course have to come chiefly from the staff.

(Continued on Page 91)

Double Laboratory Periods

In High School Chemistry

● **By Edward E. Wildman, Ph.D.,** *(University of Pennsylvania)*
DIRECTOR, DIVISION OF SCIENCE EDUCATION
PHILADELPHIA PUBLIC SCHOOLS

The number of high schools which are adopting the single laboratory period is apparently on the increase. It cannot be denied that the practice has certain advantages. But so far as chemistry is concerned at least, Dr. Wildman offers convincing arguments for the employment of the double period.

He believes that laboratory work should be emphasized, and he knows that for good laboratory instruction time is as essential as are materials and apparatus. The writer's statement about the cleaning and care of apparatus will meet with general approval.

We are glad to present this clear-cut presentation of the views of an experienced teacher and director.

●

The past decade has witnessed many changes in the work of the secondary school in America. Relatively enormous increases in enrollment, due to a variety of causes, and coincident with this increase, a marked falling off of revenues for school support have been the major factors behind these changes.

Science teachers, like their colleagues in other subjects, have given much thought in recent years to a review of the matter as well as the manner of their teaching. This self-examination has been particularly rigorous and searching among the teachers of chemistry. At the start of the century, by far the majority of our high school chemistry pupils were heading for college, and most of these found ready employment in our great and expanding producing industries. There was no question as to the type of high school instruction in chemistry then. Most of the teachers of chemistry were trained in the great European centers of chemical research and instruction or had taken their college work under teachers who were so trained. Emphasis in chemistry teaching very naturally was placed on the work in the laboratory.

THE LABORATORY'S PART IN INSTRUCTION

We, in Philadelphia, believe that this is still the place to put the emphasis in our chemistry teaching. It may well be that relatively few of our present pupils can hope to go on to college, and fewer still will find places in our great producing industries. But the laboratory is the place to teach the consumer, as well as the producer, to appreciate our dependence upon the chemical environment, and the benefits we derive from our ever-increasing control of it.

It is also the place to teach objectively those fundamental factors in what we call the scientific method of thinking, such as the relationship of cause and effect; the value of facts in arriving at a judgment; the importance of using careful techniques in our study of nature; and many others.

THE DOUBLE LABORATORY PERIOD

Therefore, when the importance of laboratory work and the necessarily increased pupil-load of today are considered, it is clear that the conscientious teacher wants and needs every possible minute in the laboratory. Pupils come to the laboratory from classes in mathematics, languages, history, or English where they meet every school day. Their laboratory work, on the other hand, is an isolated experience for them, coming only once or at most twice a week. It takes several minutes to become adjusted to the new task; to learn what apparatus is to be used; to get it out and properly set up; to learn what materials are to be studied, and to get these; then just what operations are to be performed, and why. All of these are necessary preliminaries to the work of the period, and should be done individually, with thought and care. Associations with previous laboratory work and with previous classroom and textbook work must be made individually, the teacher acting only as guide and reminder. Then the techniques of the particular and separate operations must be worked out, individually or with the help of the teacher.

A decade or two ago, when we could have laboratory sections of twelve or fifteen or even twenty, good progress could be made in such a class program by the end of a forty-five minute period. But today, with much larger numbers, and often with a part of these definitely not able or not interested to do the work of the day, and so requiring more than their share of the teacher's time and attention, only a good start can be made by the end of the forty-five minnte period. In such a period there is little or no time for thoughtful review by the group of the phenomena observed, and for drawing logical conclusions therefrom. A secondary but very important result of the short laboratory period is the fact that pupils do not have time to clean up apparatus properly and put it where it belongs,—a very important part of their training in laboratory science.

Where problem work is involved, opportunity for making the necessary calculations *at once* is highly important. The deferring of such work, and of "writing up" of the laboratory record, from any cause what-

(Continued on Page 82)

Science In The Professional Education Of Teachers For The Elementary School

● **By Helen Heffernan**
CHIEF, DIVISION OF ELEMENTARY EDUCATION,
CALIFORNIA STATE DEPARTMENT OF EDUCATION

Educators are more and more becoming aware of the importance of science in the educational experience of young children. Since teachers who are inadequately prepared cannot serve the science needs of their young pupils, teacher training institutions have now begun to take steps to provide for the necessary teacher education in science.

Here an able educator and executive discusses the basic preparation in the physical and biological sciences that the elementary school teacher should have. She tells what California is doing to meet the situation.

This article will interest you.

●

The modern curriculum finds its orientation in the nature and needs of children. The integrative theme around which the progressive elementary school program is being reorganized is the enrichment of the child's experience in his immediate environment. On this foundation, his understanding is gradually extended by experiences which help him to contrast and compare his known culture with the primitive and pioneer cultures from which it evolved. He sees man engaged in the simple, manipulative activities by which he has been able to make his environment satisfy his basic human needs.

What has been the factor responsible for the transition from primitive or pioneer society to the life of which the child is a part? It is almost platitudinous to say that science and technology are at the basis of our modern culture and that the problems which perplex the world are due to the lag between scientific progress and social adjustment. Even in the elementary school, the young child needs understanding, consonant with his level of maturity, of the ways in which man has utilized scientific and mechanical techniques in satisfying his fundamental human needs. Intelligent participation in our culture is predicated upon an understanding of its scientific bases. The lag between scientific advancement and social adjustment can be decreased only as understanding develops concerning the need for the application of a dynamic social theory to the institutions of social life. Human welfare can be guaranteed only as the products of scientific and technological development become more widely accessible and more generously shared by all our people.

SCIENCE IN THE EDUCATION OF YOUNG CHILDREN

The elementary school has had one significant ally and one formidable enemy in the work of helping children to develop fundamental scientific concepts essential to a constructive understanding of our contemporary culture. The ally has been the interest of the children in the physical and biological aspects of their environment. The interest of children in the materials of science is so apparent that the elaborate evidence on the subject produced by research students in education seems almost to be another case of belaboring the obvious.

No elementary teacher who has received from the hands of a little child a tightly clutched bouquet of bright colored flowers, or who has shared his excitement when he discovers the community life of an ants' nest, or who has watched a group of boys at the "young Injun" stage successfully repeat the experiments of the immortal Marconi, needs any tabulation of statistics to reinforce her realization that these are vital first-hand experiences valued so highly in modern education. No experiences could be more genuine than those the child has with the moving, living world of which he is a part. Fortunate, indeed, is he if he is sharing these experiences with an intelligent and understanding teacher. Through them, he can be led into a realization of his responsibilities for the intelligent use of his own life and the scientific resources of his environment; through them he may find life a richer and fuller adventure, and in them he may find deep and permanent interests for his present and his adult life.

The enemy to the opportunity which every child should have to develop basic scientific concepts and attitudes lies in the inadequacy of the teacher's preparation to give children guidance in science experiences. This inadequacy is manifested in two important ways. In the first place, the teacher has not had sufficient education in science to answer the child's questions relative to his environment or to direct him to sources of information, and in the second place, she fails to see the science experiences implicit in the major curriculum units and without which there can be no thorough understanding of the specific areas of experience.

In the former situation, the child soon ceases to consult a sterile source and unless he receives stimulation and guidance from an outside agency, his interests are diverted to other fields which the teacher apparently considers more valuable. In the latter situation, incomplete understanding in relation to an area of experi-

ence is a disintegrating influence. A child cannot experience feelings of satisfaction in regard to his study of aeronautics unless he knows something of the physical principles which make flight possible; his study of communication will be inadequate unless he knows something of the operation of the telegraph, the telephone and the radio; his understanding of the life cycle and habits of the pine beetle will result in a more intelligent attitude toward the problem of conservation. The results of insufficient teacher education in science cannot be narrowly limited to the field of science alone. Its implications for the effectiveness of the total educational program are too important to be overlooked in planning a curriculum in teacher education.

A STATE PROGRAM IN SCIENCE EDUCATION

The growing acceptance on the part of educators of the importance of science in the educational experience of young children has resulted in the production of numerous courses of study. In 1932, California published *A Suggested Course of Study in Science for Elementary Schools.*[1] Although its use is not prescribed for the schools of the state, it has stimulated interest in the field of science by curriculum departments in various school systems. One difficulty became immediately apparent as teachers included more science content in their programs. The lack of science materials organized for the teacher's use presented an almost insurmountable obstacle. Reference materials in natural science too frequently treated subjects not immediately available in the child's environment, and the almost complete dearth of materials in physical science on the young child's level added to the problem.

In August, 1934, the State Department of Education undertook an enterprise with members of the science faculties of the seven state colleges in which prospective elementary school teachers receive their education. As a result of these cooperative activities, three volumes of ten issues each have been produced under the title: *Science Guide for Elementary Schools.*[2] Plans are under way for the continuation of the project. These materials were prepared primarily for the use of elementary school teachers, but junior and senior high school teachers are finding much valuable material for use with secondary school pupils. With the use of the materials provided to the school, teachers have become increasingly aware of the need of supplementary training. The state colleges have made provision for summer session or extension courses to meet the needs of teachers in service. The large number of teachers enrolled is a recognition that these courses are meeting a felt need.

A PROGRAM FOR TEACHER EDUCATION IN SCIENCE

Continued experience and experimentation in the preparation of suitable science materials for elementary teachers and widened contact with teachers in service has concentrated the attention of this cooperating group of science educators upon the question: What preparation in science is necessary for prospective elementary school teachers? Although complete agreement has not been reached upon all details, in general, definite trends in planning teacher education curriculums have emerged.

The recommendations center around three major needs: (1) basic education in the physical and biological sciences, (2) orientation to materials and methods in science teaching in the elementary school, and (3) proper provision for science in an integrated curriculum course.

BASIC EDUCATION IN THE PHYSICAL AND BIOLOGICAL SCIENCES

The science faculty of one of our colleges has offered the following formulation of the basic lower division work essential:[3]

Physical Sciences (approximately 6 semester units).

In the physical sciences there should be enough work to give the prospective teacher a fair understanding of the physical world in which we live. This should include basic work in electricity, mechanics, the properties of matter including the ideas of molecules and atoms and some introduction to the modern ideas concerning them. There should be sufficient chemistry to develop the concepts of chemical reaction, elements, and compounds. This with necessary work on light and heat could probably be covered in a course of three semester units of credit. It should be presented with the view of enabling one to understand one's environment and to supply basic information for appreciation of work in biology, astronomy and other sciences.

The other three units should include a study of three important elements of the inanimate environment: the earth, the air, and the heavenly bodies. The first would deal with the material of the earth's crust: rock types; and with the land forms created by the action of internal earth forces, running water, soil movement, moving ice, seeping water, and wind. The second deals with the elements of weather: temperature, pressure, wind, rain, snow, clouds, and their combination into storms; and the changes of these elements that constitute weather. The third deals with a description and explanation of the heavenly bodies and their movements. All of these aspects of natural science are based fundamentally upon physics, and to a less extent upon chemistry. In this course the cultural relationships and implications would be dealt with as well as the physical.

Biological Sciences (approximately 6 semester units).

The prospective teacher should become acquainted with those broad biological principles so necessary for an understanding of himself and of society. He should understand the elementary structure and physiology of green plants which are the fundamental bases of all our food, clothing and much of our shelter. He should possess an elementary knowledge of structure and function of selected types of lower animals in order that he may better understand the anatomy, physiology, and therefore the psychology of the human type.

ORIENTATION TO MATERIALS AND METHODS IN SCIENCE

In the upper division, there should be experiences provided in making application of the basic work in the physical and biological sciences to the program of the elementary school. Methods of scientific observation, field trips and experiments suitable to the maturity of

(Continued on Page 90)

My Science Club Has Problems, Too

● **By Charles M. Eddy, M.A.,** *(St. Lawrence University)*
HEAD, DEPARTMENT OF SCIENCE, PUBLIC HIGH SCHOOL, HORNELL, N. Y.

Many more high schools than now have them should maintain Science Clubs. They are one of the most valuable means of stimulating student interest in science. But to conduct a club successfully is not easy.

Like other club directors, Mr. Eddy has encountered problems, some of which are difficult of solution. He writes of them frankly so that other club advisers may be helped, discussing such topics as building up membership, maintaining enthusiasm, handling the "joiner", and avoiding conflicts with the meetings of other clubs.

Every teacher will find food for thought in the concluding paragraphs of this practical article.

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If this paper is written in a somewhat lighter vein than it should be, I apologize. I'm merely going to discuss some of the problems of my science club. Possibly you find similar problems in your own club. Perhaps, together, we can work out solutions to some of them.

It is not my intention to sit at my desk and prepare an article holding up my science club as a model of all that a science club should be. Far be it from me to offer a set of directions and rules and regulations which, if followed to the letter, would produce a perfect science club. Far be it from my thought, too, to list numerous and glorious achievements of my club so that when you have finished reading the article (assuming that you do finish reading it), you might say "Wouldn't it be grand to have a science club like that?" or "That's fine, but he can't have the problems that I have with my club."

That is the point exactly. My science club does have problems. So does every science club. Don't let them fool you. All high school youngsters are human (I sometimes wonder, at that), and they all bring about similar problems in their relationships, whether it be in science clubs or elsewhere.

There is the problem of the "joiner." The student who likes to have his picture appear in the senior annual with one more organization, who wants to wear another pin, and who affects an interest in science for the sake of prestige. He's never much good when there's any work to be done or when programs are to be planned.

Fortunately, however, the "joiner" usually automatically eliminates himself after a few meetings. To require from new members some sort of achievement of scientific nature may help to eliminate this type, but such an assignment oftentimes bewilders a student who has a genuine interest in science but who has no idea of how to start. Such a requirement might easily become drudgery, killing any initiative and spontaneity of thought that such a desirable student might have.

At the beginning of the term a general invitation is extended to the members of the newly formed science classes, to join the science club. I wonder if this is the wisest method of filling in the membership which was lost the preceding year? This condition obviously brings up the problem of assimilation. Last Fall, shortly after the beginning of the school term, my science club set about enthusiastically to organize for the year. About ten members were students who had been members the previous year. They held a meeting, to which they invited the students of science who were interested. They planned a meeting with a dinner, to complete the organization and to elect officers for the year.

The dinner meeting was quite a success. More than thirty were present. Officers were elected and everyone came away with a great deal of enthusiasm. It is my belief, however, that the enthusiasm was not so much for science as for the social possibilities of the club. Here were thirty high school youngsters ready to direct their energies in some direction. Less than a third of them had any idea of how to start or of what to start on. Probably most of the other two-thirds were not even sure they had any particular interest in science. Consequently, many of them proceeded to lose interest as soon as they began to see that a science club meant work. I believe that building up the membership gradually, only one or two at a time, and then only after the applicant for membership had demonstrated his or her interest, willingness, and ability in the field of science, might have succeeded in strengthening this club to a much greater degree.

Then there is trouble with conflicting meetings. In an average-sized school, there are numerous organizations. Many of the members of my club who really have a keen interest in science are the ones who also have an interest in several other activities. Isn't it true that the best students are the busiest? The dramatic club, the glee club, the band, the aviation club, the boy scouts, are bound to conflict with the science club. We have tried having meetings during school hours, after school hours, evenings, and on different days and different evenings, but other activities always interfere. There's nothing much can be done about it, except to choose a time of meeting each week when there is the least number of conflicts. Then those who choose to give up something else in order to belong to the science club are obviously the ones who will make

(Continued on Page 84)

This Is Station HJV

● **By Raymond E. Vecchio, M.D.,** *(University of Rome)*
PITTSBURGH, PENNSYLVANIA
and Reverend James McVann, C.S.P.
CHURCH OF SANTA SUSANNA, ROME

Not every Catholic appreciates the rare privilege that is his when he is permitted to hear over the radio the voice of the former "Prisoner of the Vatican." Few people know how this modern miracle is accomplished.

This article, which was written from information supplied by Father McVann and Doctor Vecchio, tells something of the radio station in Vatican City over which the voice of His Holiness comes to the people of the world.

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The words of the announcer are plainly heard. He speaks in Italian.

"This is radio station HJV, Vatican City."

The whole world listens.

This is a momentous day for Catholics. Through the modern miracle of the radio the faithful everywhere are to be permitted to hear the actual words of Pope Pius XI, the Holy Father whom millions of his children will never have the opportunity to see or to hear in person. For the first time in history a Pope is to broadcast a message personally. Millions wait in thrilled expectancy. They are not disappointed. Soon comes clearly and distinctly the voice of him for whose words they have been listening. The Supreme Pontiff speaks, addressing all the nations of the earth. People of all beliefs throughout the world give respectful attention.

This historic first papal radio address of Pope Pius XI was made on February 12, 1931, on the ninth anniversary of his coronation as Supreme Pontiff. His Holiness spoke over the then newly-installed Vatican City radio station which had been built and presented to him by famed Guglielmo Marconi, and which he was now dedicating. So important was this event in Church, world, and radio history that arrangements had been made for the people of every country to listen to his voice over the greatest number of radio stations that have ever been joined together up to that time to broadcast a single event.

The ceremony was simple but impressive.

Shortly after ten-thirty o'clock in the morning Americans might have heard a fanfare of trumpets announcing the arrival at the station of the Holy Father. In a few brief sentences Signor Marconi presented the station to His Holiness, and invited him to speak. For fifteen minutes Pius XI spoke in Latin, addressing himself first to all creation, next to all Catholics, and then to all non-Catholics. He reminded the rich that they merely hold their wealth in trust. He told the poor that in their search for the material things of this world they must not forget to strive for spiritual wealth also.

During the second part of the dedication of the station, His Holiness spoke in Italian, thanking Signor Marconi for the gift of the station, admitting him to membership in the Papal Academy of Sciences, and conferring on him other honors. Marconi replied briefly. The Rev. G. Gianfranceschi, the first director of the station, also made a short address. Then, for the benefit of all English-speaking people, the Right Reverend Monsignor F. J. Spellman, D.D., of the Archdiocese of Boston, read an English translation of the Latin address *Qui Arcano Dei Ausilio* just given by the Holy Father. This was followed by a two-way conversation between Monsignor Spellman and officials of the National Broadcasting Company, for the Vatican City radio station is equipped for "duplex" telephony and telegraphy between the station and other parts of the world.

Since this memorable first radio appearance, the voice of the Supreme Pontiff has been broadcast a number of times, each time on a topic of great importance. No one can estimate the great benefit to the world that may have come from his words, spoken directly to his people.

It seems especially fitting that Pope Pius XI should

HIS HOLINESS, POPE PIUS XI, INAUGURATES THE RADIO STATION AT VATICAN CITY.

be the first Pope to utilize radio, for throughout his reign he has been a steady and consistent patron of scientific projects. The buildings of Vatican City have been modernized in many ways. New electric elevators have been installed in the Vatican Palace, automobiles have displaced older means of conveyance, a new railway station has been erected, and a papal train is in operation. The Papal Academy of Sciences has been rejuvenated and His Holiness has expressed his interest in science in many other ways. In 1933, for the first time, a Pope permitted himself to be seen and heard in motion pictures.

A VIEW OF THE STUDIO

It was, then, a special pleasure for this scientific-minded Pope to open the new broadcasting station, one of the most powerful in the world and a model of its kind. So superior did it seem to other stations of the time that the donor was asked what unusual things he had done to make it so. With characteristic modesty Marconi replied that the Vatican authorities were responsible, for they had imposed no restrictions; consequently, everything connected with the station was the best that could be obtained.

The radio station is housed in a simple, butter-colored, brick building of one story, situated on a plot that lies almost at the peak of the Vatican gardens. About it are lawns and a formal garden that slope down toward the administration building of the papal government. Above it looms the highest part of the Leonine Wall, the twin towers of the transmission, and the two observatories. From the radio station one can see the whole of Rome, and afar off the Alban and Sabine Hills, and even the Appenines of Abruzzi.

The building itself contains a large hall with control tables for the amplifiers and transmitter, a receiving room, a room for the battery chargers, a machine room, a room for tubes, and the director's office. Nearby, just outside the Leonine Wall, are the two towers, 61 meters tall and standing 90 meters apart, between which two transmitting aerials of the Marconi type are suspended, one for each of the wave lengths used. Between the same towers is hung an aerial which serves as a feeder for the great duplex receiving apparatus. The length of the aerial can be controlled from the receiving room. From the building of the transmitting station electrical energy is supplied to the aerials by two separate feeders which are composed of concentric copper tubes like those used by the British broadcasting network. The feeders lie in a tunnel which passes under the wall of Leo IV.

The power for the station comes from the power plant of Vatican City which supplies a continuous current of 120 volts. The radio station uses about 80 kilowatts, and transmits up to 15 kilowatts. The powerful transmitting apparatus resembles the short-wave transmitters used in Great Britain. For radio-telephony and radio-telegraphy, high-speed waves of 19.84 and 50.26 meters are used.

The complete transmitter consists of four principal panels. The first of the panels is the principal magnifier for both waves. The second panel comprises the intermediate magnifiers and the oscillator pilot of the Marconi-Franklin type with tubes for the shortest waves. The third panel contains the intermediate magnifiers and the oscillator pilot for long waves. The fourth panel contains the modulator for telephony combined with an absorption signal unit for high speed telegraphy.

An exceptionally sensitive Reisz-Marconi microphone is used in telephonic work. For telegraphy there is a Wheatstone apparatus with an annexed ribbon perforator having a capacity of 200 words a minute. It is controlled by means of a writing oscillograph. An apparatus for the transmission and reception of photographs was a later addition.

THE RADIO STATION VIEWED FROM THE ETHIOPIAN COLLEGE

From its opening until the time of his death in 1934, the Papal radio station was under the direction of the Reverend G. Gianfranceschi. Now it is operated by the Reverend P. Soccorsi, a Jesuit priest of Italian birth and training. This young scientist has a busy life, for he not only directs the Vatican City radio station but he works at the Papal observatories as well. In addition, he lectures at the Gregorian University.

The Scholastic Classification of the Sciences

● **By Reverend James F. Carroll, C.S.Sp., S.T.D.,** *(University of Fribourg)*
VICE PRESIDENT AND DEAN OF THE COLLEGE OF LIBERAL ARTS AND LETTERS, DUQUESNE UNIVERSITY

Many uninformed people believe that science is strictly modern in origin. Yet the ancient Greeks, and later the medieval Schoolmen were greatly interested in what constitutes science, in the number of real sciences into which the great body of science logically can be divided, and in the interrelation of the several divisions.

Father Carroll writes of the scholastic idea of science in general and of the reasons why the Aristotelian classification of the sciences was adopted. He discusses the interdependence of the five parts and shows that while logic is the most fundamental, all the sciences also depend upon metaphysics and ethics.

In this article you may follow the reasoning of great thinkers.

●

The notion of Science, the number of real sciences, and the mutual relation between them, are topics that are both very modern and very important. It may come as a distinct shock to many so-called moderns to know that these same questions were discussed by the ancient Greeks, and philosophically analyzed by Aristotle, from whom medieval scholasticism borrowed copiously. This paper is not a critique, but rather a re-statement of their findings.

Science in general is knowledge, but all knowledge is science, using the definition of science in a strict sense and speaking of it as certain knowledge, had by demonstration. Hence, it is occupied always with conclusions. It is occupied, also, only with necessary and universal things. For science demands certitude of mind. But the firmness of our adherence to a truth must depend on the stability, so to speak, of the object considered. Now, individual objects, contingent things, are changeable; they are one way today and another tomorrow. Whereas, to be always the same is a property of necessity and universality.

We obtain a universal concept by comparing many objects, and then mentally removing what is proper to each. This setting aside of individual notes, this preparation to make an object intelligible, the philosopher calls abstraction. Every science, therefore, postulates abstraction, is founded on abstraction; and, according to the method and the degree of abstraction, will be the ranging coordinately of the sciences.

Science has a two-fold object: material, or the subject matter of the science, that about which it treats; and the special viewpoint taken of it, which is called the formal object, for all the objects in a field that can be regarded under one peculiar aspect are unified by this aspect. For instance, many, many objects are in the field of physics; but all are considered from one point of view: viz., the phenomena of bodies. On the contrary, it may happen that a subject materially one, may form the object of many sciences, being considered in each under a peculiar aspect. Thus, man may be the object of psychology, pathology, physiology, etc.

As we have said, in order that objects different in themselves may be reduced to one point of view, we must abstract. There are three stages, three degrees of abstraction, from material objects. When the mind considers corporeal things without taking account of the notes by which they are individualized, it is considering bodies that can be perceived by our external senses, and as subject to change and movement. *Physics*, including all the natural sciences, has these as its object. But, again, we can consider quantity in these objects, quantity as intelligible, and disregard all other elements. This is the entire field of *mathematics*. Finally, there is a science that ascends still higher in abstraction and generalization, a science that passes over the reality of mutation, and considers all things material apart from their materiality. This is the science of *metaphysics*.

Thus, we have in the realm of abstraction from matter a trinity of sciences, namely physics, mathematics and metaphysics.

There is, however, a second kind of abstraction. It is called abstraction from reality, a branch in which knowledge is subordinated to our mental activity and to our behavior as human beings. A rule or standard either of thought or of action, is an abstraction. It is mind-made. The laws of nature or the laws of prosody, for instance, what are they? They are nature's way of doing things, or they are the very mechanism of poetry. They are in nature; they are in poetry; but scientists, or men of letters, examining in their special fields, have drawn out, really *abstracted* them, and given us things which are therefore abstract rules. As such, they do not exist in reality, outside the mind. They belong to what the Schoolmen called the *ens rationis*.

Every act of my reason, every act of my mind results in a new entity, existing in a new manner, existing in me. It is known as a *first intention*. Now if I reflect on that being or that act, it becomes doubly mental: it becomes an act of the mind on an act of the mind. And if the entire *raison d'etre* thereof is to put order in my ideas to coordinate and subordinate them properly in order to attain truth, I have *second intentions*, as they are called. *Logic* is the science of

(Continued on Page 88)

Theories Of Electrolytic Solutions

● **By Sister Mary Dorcas Smith, Ph.D.,** *(Catholic University)*
ASSISTANT PROFESSOR OF CHEMISTRY AND PHYSICS, SETON HILL COLLEGE, GREENSBURG, PA.

We consider it a privilege to prevent this scholarly paper by an important Sister scientist.

At first reading its substance may be, and probably is, beyond the full comprehension of many teachers of high school science. It will do them good to study it. No teacher of physics or chemistry can fail to obtain something of value from its perusal.

The enormous amount of careful research that has been done in preparing this paper is clearly evident. We feel that its publication should stimulate other teachers to greater effort in this direction.

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HISTORY

In the discussion of the theory of ionic dissociation on the occasion of the Faraday Lecture before the Chemical Society in London, May 25, 1914,[1] Arrhenius reviewed the development of thought in chemistry and pointed out that almost from the beginning two ideas were prevalent in all processes, however obscure: (1) an exaggerated opinion of the importance of color, and (2) the conception that the dissolved state is extremely favorable for chemical operation. This latter observation is definitely set forth in a statement of Isadore Hollandus in the 15th century: "the philosophers have followed the direction given by nature, and at first transformed everything into water (i.e., dissolved it) before they used it in the art of chemistry." The alchemists believed that substances do not interact unless they are dissolved.

Faraday's work (1833) on the deposition of matter by an electric current, resulting in his two laws of electrolysis:

(1) The amount of chemical action is proportional to the amount of current passing through a solution,

and

(2) When the same quantity of electricity passes through different solutions, the mass deposited is proportional to the chemical equivalents of the elements,

demanded a theory of constitution of matter to supplement Dalton's atomic theory. As early as 1859 Clausius, in order to explain the electrical conductivity of salt solutions, supposed the salts to be dissociated to a chemically insensible degree.

The views of solutions current before the time of Arrhenius were gradually changing, in order to explain the effects observed by Faraday and Hittdorf in their work on electrical conductivity and transport measurements. About 1882 these ideas, though hazy, were coming to be formulated to include the notion that some part of a solution exists in the ionized state as positive and negative radicals which were assumed to be constantly changing partners. Salts were said to contain a small fraction of "active" molecules in which the radicals were not closely combined.

In 1883, Arrhenius investigated the electrical conductivity of different electrolytes and concluded that the conductivity increased with dilution because the number of conducting molecules increased at the expense of non-conducting ones. At infinite dilution all the molecules are conductors. This hypothesis led him to state: (1) that molecular conductivity at infinite dilution is an additive property for all electrolytes, and (2) that the electrically conducting molecules are the same as the chemically reacting molecules. At infinite dilution all acids must be of the same strength. Hence the velocity of a reaction caused by an acid is proportional to the number of electrically conducting molecules per unit volume.

The appearance of Arrhenius' memoirs led to much important work, notably the researches of Ostwald, who made conductivity measurements on thirty-four acids and showed his results to support Arrhenius' contention of the dependence of a reaction on conducting particles. He also showed that the relative strength of weak acids increases and approaches that of strong acids at infinite dilution, and that the law of Mass Action of Guldberg and Waage was applicable to ionic dissociation. From these considerations he formulated his well-known dilution law.

In 1885, Arrhenius published the results of his work at Upsala on the conductivity of electrolytes in which he concluded that mineral acids are almost completely "active." Van't Hoff's work on osmotic properties of solutions pointed to the same conclusion; i.e., a regular enhancement of the observed effects for non-conducting solutions, but an abnormal increase for electrolytes. For an electrolyte like NaCl he observed about twice the expected effect; for $CaCl_2$ the effect was three times that anticipated. His results strengthened Arrhenius in the belief that his theory of ionic dissociation presented a satisfactory explanation of these anomalies.

All were not convinced of the notion of ions or dissociation. In 1885, Raoult measured the freezing point depression of many salt solutions. Since these were far from the results anticipated from comparison with non-conducting solutions, he formulated an exaggerated theory of individuality among radicals, maintaining that every radical has its own molecular depression. A univalent negative radical had a depression of 2, a positive, 1.5; bivalent negative radical, 0.8, etc. If he had supposed dissociation, he would have ascribed the same molecular lowering to all radicals. When a freez-

ing point depression proved to be twice that expected, he supposed the molecule to be twice as great as the formula indicated.

Still there was not enough evidence to support the hypothesis that electrolytes are to a great extent dissociated into ions, that is, not enough to make it generally convincing. In 1886, Van't Hoff published an article pointing out the similarity of dilute solutions to gases. He showed how Raoult's freezing point measurements displayed the double effect of salts like KCl. For gases, the only explanation of increase in pressure is the law of Avogadro—that there must be an increase in the number of gas molecules present. Hence, the abnormal freezing point of KCl must be due to the greater part of it being dissociated into potassium and chloride ions.

Strengthened by the support of Ostwald's and Van't Hoff's evidence, Arrhenius published his theory of ionic dissociation[2], which included three main points: (1) a dissolved electrolyte dissociates into ions to a greater or less extent; (2) the degree of dissociation depends on the concentration of the solution and increases with dilution, at infinite dilution the dissociation being complete; (3) the fraction of salt ionized can be calculated from the conductivity measurements.

LaMer[3] outlines the factors leading to the development of the classical theory of dissociation as follows: (1) the neat and practically instantaneous exchange of inorganic radicals as compared with the slow reactions of organic chemistry; (2) the increase in equivalent conductivity with dilution to a finite limit set by the mobility of the ions; (3) Van't Hoff's observation that the osmotic properties of this class of substances always exceeded that predicted by the gas law equation valid for non-electrolytes in dilute solution: $\pi = cRT$. The theory rests on four strong foundations: evidence from freezing point depression, electrical conductivity, chemical reactivity, and additive properties of solutions of electrolytes. It proved formidable enough to resist the attacks of years and still is adequate, in the opinion of many investigators, to explain the reactivity of weak electrolytes.

All were not ready to accept the theory. In 1890 an English chemist, Pickering[4], said, "The theory of dissociation into ions is altogether unintelligible to the majority of chemists. It seems to be quite irreconcilable with our idea of the relative stability of various bodies, and with the principle of conservation of energy. How can we regard it probable that compounds of such stability as H_2SO_4 or HCl should be thus dissociated by water, while less stable ones such as HCN should remain intact? How can we admit that the more stable a body is, the more prone it is to be dissociated? . . . Whence come these electric charges and by what agency are they brought into play?" These problems have all been cleared away by the elucidation of the electron theory of structure.

It soon became apparent that the theory was not in agreement with the observed change of conductivity of strong electrolytes with dilution. Many attempts have been made to correct the Ostwald dilution law to make it conformable to strong electrolytes. Among these are the corrections of Rudolphi[5], Van't Hoff[6], and Storch[7]. Their proposals led to the general formula usually designated as the Storch formula:

$$\frac{(c\alpha)^2}{c(1-\alpha)} = K + k(c\alpha)^m$$

where K, k and m are characteristic constants. When $k = 0$, we have Ostwald's well known dilution law. Kraus and Bray[8] proved the validity of the simple dilution formula for strong electrolytes up to concentration of 10^{-1}. For concentrations greater than this the Storch formula expresses the results, but it is wholly empirical.

At the conclusion of his Faraday Lecture, Arrhenius gave the status of his theory[1]: "As a general conclusion it may be stated that the difficulties inherent in the theory of electrolytic dissociation have been overcome only within a very recent period, when the observed facts have been more closely examined. It is now our task to investigate the causes which interfere with the simple laws which govern these deviations."

Many investigators were not convinced that the dilution law was valid for all electrolytes as a limiting law. A. A. Noyes, one of our American chemists, contended that quite a different law governed the effect of strong electrolytes. The theory of Arrhenius presumed constant mobilities for ions at all concentrations; this proved to be a weakness of the theory. Noyes[9-10] brought forth evidence of a change in the value of transport numbers with concentration. Since transport numbers are a measure of the mobility of ions, this means a change in mobility with concentration. At this time chemists began to promote theories of complete dissociation of strong electrolytes, together with a suggestion of the existence of forces between oppositely charged ions to account for the lack of one hundred per cent effective dissociation. In 1900, Van Laar[11] suggested the idea of electrostatic forces between ions to explain divergence from ideal conditions. He denied the possibility of independent ions. Sutherland[12] and Bjerrum[13] fostered the idea of electrostatic action and denied the existence of un-ionized molecules of electrolytes. Their theory marks the beginning of the theories of complete dissociation.

Even before the appearance of these last two articles, A. A. Noyes had suggested the idea of complete ionization in a publication in *Science*[14] in which he stated that experimental evidence would lead one to conclude that all salts are completely ionized up to fairly high concentrations. The decrease in conductance he attributed to a change in migration velocity. At the same time American physical chemists, under the leadership of G. N. Lewis and others, were developing a firm thermodynamic background for a better understanding of the problem.

Bjerrum, and a little later, Milner[15], were the first to propose a definite hypothesis of complete dissociation. Their contention was that strong electrolytes are

completely ionized at moderate concentrations, and deviations from the laws of perfect solutes are due to inter-ionic forces. Bjerrum worked with optical properties of complex chromium salts and found the color of the solution to be independent of salt concentration. The observed decrease in equivalent conductance with increased concentration he ascribed to the decreasing mobility of the ions resulting from inter-ionic attraction. Modern experimental evidence has substantiated this point of view, in particular the X-ray data of the Braggs[10] who found the crystals to be made up entirely of ions held together by electrostatic attraction.

G. N. Lewis[12] in his thermodynamic treatment of the problem, introduced the concept of "fugacity" and "activity." He defines activity as a thermo-dynamic quantity having the dimensions of concentration and determined by the work necessary to transport reversibly one mole of component at constant temperature from some standard reference state, whose partial molal free energy is represented by $\bar{F}^{\circ}$, to the given state under consideration: $\bar{F} = RT \ln a + \bar{F}^{\circ}$. The standard reference state is that at which the solute reaches the condition at which it obeys the gas laws, i.e., the conditions at infinite dilution. The activity has been termed the "thermodynamic concentration" and is related to the stoichiometrical concentration by a ratio termed the activity coefficient:

$$f = \frac{activity}{concentration} \quad \text{or} \quad a = fc$$

So we see that the activity coefficient f is a measure of the degree of obedience to the gas laws which the solute exhibits; that is, the thermodynamic degree of dissociation.

In 1921, Lewis and Randall[13] introduced the important function of ionic strength which is a means of reducing all solutions to the same environmental conditions:

$$\mu = \tfrac{1}{2} \sum m z^2$$

where m is the molal concentration of the ions and z its valence. They formulated the law, derived from a study of available data "that in dilute solution the activity of a given strong electrolyte is the same in all solutions of the same ionic strength." LaMer[10] states that "the generalization that the activity coefficient of an ion is determined in dilute solutions solely by its valence and the number and valence of all the surrounding ions, and not by specific individual properties, as is the case in weak electrolytes, constitutes the strongest empirical evidence for the thesis that in strong electrolytes the anomalies are due to electrical effects and not to incomplete dissociation."

Milner[20] was the first to give a quantitative statement or equation relating the strength of the electric field surrounding the ions with the divergence of the ion from the ideal solute; but his method was so mathematically complex that it was impossible to apply it to any but 1-1 salts. He may be called the father of the interionic attraction theory. Ghosh[21] proposed a similar solution but his method was based on faulty reasoning. Its importance lies in the fact that it activated other investigators and finally led to the famous Debye-Hückel publication in 1923[22]. As Scatchard[23] states it, "the paper of Debye and Hückel is a much more important event in the life of the interionic attraction theory than its birth itself."

The fundamental idea underlying the theory is that, owing to electrostatic attraction, an ion of a given sign will on the average be surrounded by more ions of unlike sign than ions of like sign. When the solution becomes greatly diluted, the ions become so far removed from each other that this mutual electrical attraction is reduced to zero and a uniform field prevails. Hence, the conditions of an ideal solute are reached and the gas laws are valid. The activity of an ion, or the measure of its deviation from the gas laws is found by calculating the electrical work necessary to produce isothermal dilution.

Debye first determined the manner of distribution of the charge about an ion, or as it is termed its "ion atmosphere." This he did by an application of the Boltzmann principle of probability distribution and the use of the electrical forces expressed by Coulomb's law. From these he calculated the internal electrical work by the Gibbs-Helmholtz equation. The simple mathematical statement of the law is:

$$-\log_{10} f = a' (-Z_1 Z_2) \sqrt{\mu}$$

where a' is composed of many constants: and is equal to the expression:

$$\frac{1}{2.303} \left[\frac{N^2 \epsilon^2 \sqrt{2\pi}}{(10 R D_0 T)^{\frac{3}{2}}} \right]$$

There is much evidence for and against the theory. Although today it is generally agreed that it is fundamentally correct, there are many factors not yet interpreted completely. If the statement of the limiting law be examined, it is seen that if the activity is plotted against the square root of the ionic strength a straight line should result. For low concentrations the plot of the measured activity against the ionic strength does yield a straight line, particularly in the case of simple 1-1 salts or symmetrical salts.

Basing his development of the Debye-Hückel theory, Onsager[24] derived an equation for calculating the conductivity of electrolytes. The general form of the equation for a 1-1-salt in water at 18 degrees C:

$$\Lambda = \Lambda_0 - (0.224 \Lambda_0 + 50.5) \sqrt{C}$$

is very useful for calculating Λ_0. The constancy of Λ_0 provides a remarkable check for the validity of the equation. The application of this equation to various valence types points to incomplete dissociation of salts of higher valence types. The deviation from Onsager's equations have been used to express dissociation constants[25].

Bronsted and LaMer[26] tested the equation for salts

(Continued on Page 85)

Important Discoveries
Made At The Institutum Divi Thomae

In the June, 1937, issue of the SCIENCE COUNSELOR the Reverend Cletus A. Miller, Dean of the Institutum Divi Thomae, gave a brief account of this new Catholic graduate school of scientific research which was established at Cincinnati, Ohio, in 1935, by the Most Reverend John T. McNicholas, Archbishop of Cincinnati. The purpose of the school, Father Miller explained, is to foster training in science with emphasis upon research. The Catholic Church has always taught that there is no fundamental quarrel between science and religion, and that there is only one truth which it is the common duty of scientist and religious alike to seek.

The new institute is a training ground for science professors from Catholic colleges as well as for lay students. Investigators of various religious beliefs, Catholic, Protestant, and Jew, work hand in hand toward unravelling the fundamental secrets of nature and interpreting them in the light of scholastic philosophy. Dr. George Speri Sperti, known for his vitamin discoveries, his invention of the Sperti ultra-violet lamp, and for years of research in pure science as Director of the Basic Science Research Laboratory, University of Cincinnati, is Director of the Institutum. Father Miller, in addition to being Dean, is editor of a new Institutum publication, *Studies of the Institutum Divi Thomae*, the first number of which has recently been issued. From its articles, which report the results of some of the researches that are being conducted at the Institutum, we have abstracted and here present material that will be of interest to our readers.

THE DEVELOPMENT OF PLANT PIGMENTS IN SEEDLINGS GROWN IN THE DARK

Studying the effects of light on plants in order to get a better understanding of how the green pigment, chlorophyll, of plants enables them to utilize the sun's energy, Dr. William A. Beck and his associates have come to the conclusion that while light is needed for the development of chlorophyll in plants, it is not needed for the development of a mysterious colorless substance which may be the forerunner of chlorophyll.

Dr. Beck grew sunflower seedlings under various conditions of light and pressure. The yellow pigments, xanthophyll and carotene, were found to develop regardless of whether the plants were exposed to light or not. The green plant pigment, chlorophyll, developed only in the light. In those plants which were not subjected to light, a material seemed to be present in place of the chlorophyll. This could be judged by chemical methods used to extract the various pigments from the plants. It was believed to be the substance from which chlorophyll is formed when the plant is exposed to light.

After removing the pigments from the plants by various chemical methods, Dr. Beck used a sensitive photo-electric device of his own design to determine the quantities in which they had been present in the different plants.

In continuing his studies on the forerunner of chlorophyll, Dr. Beck hopes to show how it is changed under the influence of light into chlorophyll.

THE ABSORPTION OF VITAMIN D THROUGH THE SKIN

Cod-liver oil haters need no longer subject themselves to torture in order to get an adequate supply of vitamins A and D according to investigations recently completed by Research Professor Father Cornelius Jansen and Research Associate Agnes Helmer of the Institutum Divi Thomae. Their studies show that oils containing these vitamins are as effective when absorbed through the skin as when taken by mouth.

In their experiments, rats kept on appropriate vitamin-free diets until they showed the symptoms of vitamin deficiency were rubbed daily on portions of their shaven backs with cod-liver oil, halibut-liver oil, or carotene and vitamin-D-containing soap. Both cod-liver oil and halibut-liver oil contain vitamins A and D, while carotene is the yellow pigment which is changed in the livers of animals into vitamin A. The rats uniformly showed rapid recovery from their vitamin-deficiency symptoms under the influence of the treatment.

The investigators point out that it is not necessary that the vitamins given through the skin be applied in oils. Soap, lotions, or even perfume or other cosmetics can be used as carriers of the vitamins, they say. The experiments with soap showed the efficiency of absorption of vitamin D, applied in this way, to be about the same as when it is taken by mouth.

THE STIMULATION OF YEAST RESPIRATION BY RADIATIONS

A clue to the mechanism of wound healing and possibly of cancer has been found as the result of extensive studies on the effects of ultra-violet light, X-rays, and other harmful agents on cells, according to a recent report.

This research, outlined and directed by Dr. George Speri Sperti, was performed by Professor Fardon in association with Sister M. Jordan Carroll, O.P., and Sister M. Veronita Ruddy, O.P., who conducted experiments in which a study of the effects of ultra-violet light on cells and tissues was made. It was discovered that injured or dead cells gave out substances which

caused increased respiration of normal cells. In this way, injured or dying cells seemed to be capable of calling for aid upon the surviving cells in a cell community, thus insuring the continued life of the community.

In these experiments, use was made of ingenious devices called "respirometers" which enable the rate of breathing, or respiration, of small groups of cells to be studied. The breathing rate of cells exposed to ultra-violet rays was compared with the breathing rate of unexposed cells. When only a portion of the cells was killed, it was found that the breathing rate increased. Later experiments showed that the injured or killed cells secreted substances which stimulated the rate of breathing of the remaining uninjured cells.

Professor Fardon and his associates were able to separate the stimulating factor from the injured cells in the form of a fluid containing impurities as well as the active material. This fluid was found to remain active when kept for long periods in a refrigerator or when subjected to heating or irradiation with ultra-violet.

Whether the cells were injured by ultra-violet light, heat, or X-rays seemed immaterial as far as the production of the stimulating substances was concerned. Even mechanical injury seemed to cause production of the materials, although to a lesser extent. Various kinds of cells, such as those from liver tissue, kidneys, spleen, and yeast were tried with similar results.

In relation to cancer, the Institutum scientists noted that malignant growths are the result of abnormal activity on the part of cells and that they frequently follow injuries of the X-ray burn type. In such instances, at least, they suggested that the mechanism might be similar to that of wound healing, differing from it in being carried too far with failure of the process of repair to stop when it should.

THE ULTRA-VIOLET ABSORPTION SPECTRA OF GROWTH PROMOTING PREPARATIONS

That the growth-stimulating substances secreted by injured cells may come from the innermost part of the cell, the nucleus, is indicated by investigations carried out by Dr. John R. Loofbourow, Father Lawrence Schmieder, Sister Miriam Michael Stimson, O.P., and Sister Cecelia Marie Dwyer, S.C., of the Institutum Divi Thomae.

Dr. Loofbourow and his associates studied growth-stimulating substances obtained from ultra-violet injured cells and from yeast and other sources by means of an ultra-violet spectrograph. Measurements showed these substances to be similar chemically to materials of the cell nucleus.

It is known that the nucleus of the cell is the part in which reproduction originates and from which growth is largely controlled. Dr. Loofbourow cautioned, however, that the experiments are too preliminary to establish beyond all question that this vital part of the cell is the part from which the stimulating factors are secreted.

BIOLOGICAL ASSAY OF DIALYZED FRACTIONS OF BIOS

Studies on the cell hormone, bios, by passing it through thin membranes of collodion have demonstrated that it may be several substances rather than a single substance, according to the work of Dr. R. J. Norris and Sister Mary Jane Hart, O.P., of the Institutum Divi Thomae. Interest in this cell hormone has been aroused recently by discoveries at the Institutum which show that it is similar to substances secreted by injured cells which seem to play a part in the mechanism of wound healing and cancer.

It was formerly thought that bios was a single substance. The new work, in which the properties of bios preparations sent through thin membranes for various lengths of time were compared, is thought to show that there may be at least three fractions of bios, one stimulating cell growth, one stimulating fermentation, and one stimulating the rate of breathing or respiration of cells.

Dr. Norris pointed out that many of the vitamins were originally thought to be the same substance until careful research showed them to be entirely distinct materials with different effects on the body.

THE STIMULATION OF GROWTH, RESPIRATION AND FERMENTATION BY BIOS AND BIOS-LIKE SUBSTANCES

Dr. R. J. Norris and Sister M. Veronita Ruddy, O.P., have discovered that stimulating substances given out by cells injured with ultra-violet light resemble in some respects a stimulating substance called "bios" which was first obtained from yeast cells by Pasteur, the famous French scientist, who discovered bacteria.

Dr. Norris and his associate compared preparations of bios which they made from yeast with substances secreted by ultra-violet injured yeast cells. They found that the materials were alike in their ability to stimulate cells to greater rates of breathing, growth and fermentation, and that they were similar in their resistance to heat and other agents.

Further investigations showed differences in different preparations of bios and different fractions from injured cells, however. The investigators concluded that normal and injured cells may be able to secrete a number of different substances which act like hormones, helping cells to live together in community life. Thus there seems to be, according to their findings, a kind of a chemical control of the social life of cells.

PHOTOTROPIC RESPONSE OF DROSOPHILA MELANOGASTER AND ITS MUTANTS

Unlike the female of the human species, female flies seem to be less interested in color than their male companions, according to experiments of Professor John C. Fardon, Sister M. Jordan Carroll, O.P., and Rev. William A. Sullivan, O.P.

Fruit flies, having various kinds of eye color, were placed in containers in which they could be observed.

(Continued on Page 92)

You Should Read

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Biology:

A Study of the Principles of Life for the College Student

● *By* REV. U. A. HAUBER, Ph.D., of St. Ambrose College (Davenport, Ia.) and SISTER M. ELLEN O'HANLON, Ph.D., of Rosary College (River Forest, Ill.) F. S. Crofts & Co., New York, 1937, $3.90.

This general biology text briefly surveys the plant and animal kingdoms, and discusses more at length the basic vital processes as exemplified in both. It further combines "principles" with "types", which has forced the authors to curtail and over-simplify their treatment of the latter. Hence, those who prefer the typal approach will not be satisfied, and the same is true of those who prefer to take their plants or animals straight.

The illustrations and diagrams are abundant and leave little to be desired. The presentation is clear and the work has other excellent features. But we cannot subscribe to the verdict given by *America's* reviewer, that here at last we have the long-awaited Catholic text on biology.

Chapter VII (on life) and Chapter LII (on mind) abound in philosophical inaccuracies, which are not atoned for by the fact that in this book "the name of God is not taboo." Biology is more directly concerned with the *soul* than with the subject of God; and Catholic philosophy has formulated excellent definitions of *life* and of the *soul*, which we look for in vain in the present text. Instead, we find on page 469 the amazing statement: "The terms *soul* and *spirit* are but figures of speech. The reality is man himself"—language so loose that it seems to insinuate that man's soul is an *unreality*. This is not only bad philosophy, it is bad rhetoric, too. What figure of speech is *soul?* The *derivation* of this word is unknown. As for its *meaning*, there is nothing figurative about that—it signifies a *physically real* part of human nature, not only really distinct from the human organism, but separable therefrom and capable of surviving the dissolution of the body.

There are certain scientific inaccuracies as well. To pass over the antiquated view of *photosynthesis* expounded in chapter V, the authors assure us in the Preface (p. viii) that "evolution is a law of nature", which, to say the least, is a grave abuse of the term *law*. Alluding to the laws of Mendel, the great cytologist, Edmund Wilson, defines laws as "definite quantitative rules that are capable of arithmetical formulation." (*Biology*, p. 15.) And Svante Arrhenius, referring to Ohm's law, declares: "*Quantitative* formulation, that is, the establishing of a formula between different quantitatively measurable magnitudes, is the peculiar feature of a law." (*Theories of Chemistry*, p. 3.) Will Father Hauber kindly formulate quantitatively the "law" of evolution? He knows full well that he is powerless to do so; for "biologists have not been able to formulate any definite quantitative or mathematical laws regarding a process of evolution." (*Backgrounds of Biology*, Giesen & Malumphy, p. 155.)

Again, the authors refer several times to evolution or transformism as an *established fact* and cite certain cases of poyploidy and hybridism as factual proof of the origin of *new species* by transformation of old species. Thus, they instance *Raphanobrassica*, which a Bolshevik scientist is said to have produced by crossing a cabbage with a radish. Assuming that we are not being hoaxed as Pawlow hoaxed us with his educated white rats in 1924, we have here a case of hybridization complicated by polyploidy, the result being a tetraploid form that is *intersterile* when back-crossed with either parent stock. But this is not enough to constitute it a *new species*. To be accepted as such, it must pass not only the *intersterility* test but also the *viability* test. Now, as is well known, *no domestic* breeds of plants or animals have the hardihood to survive in the wild under natural conditions. As *Raphanobrassica* is presumably no hardier than the cabbage and the radish, it does not qualify as a new species. Certainly, Father Hauber's enthusiasm in this connection is not shared by Henry A. Wallace's Department, which tells us:

"Cytologists have revealed a bewildering assortment of chromosome numbers in the organisms they have studied and these do not seem to bear any relation to the larger aspects of the evolution of races of living things. It does not follow that the more chromosomes the higher the organism. Thus a man has but 48 somatic chromosomes while a rooster has 74 and one species of sugarcane has 112." (*1930 Yearbook of Agriculture*, p. 180.)

Were the Hauber-O'Hanlon text written by non-Catholics, I should feel no hesitation in recommending it; for then Catholic teachers and students would take all these errors "with a grain of salt." But occurring as they do in a reputedly "Catholic" textbook, they are quite likely to be taken seriously and so do considerable harm.

Msgr. George Barry O'Toole,
The Catholic University.

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Science In The Elementary School

Including an Activity Program

● *By* W. C. CROXTON, Ph.D., State Teachers College, St. Cloud, Minnesota. New York, McGraw-Hill Book Company, Inc., 1937. ix + 446. $3.00.

This is a stimulating book, a challenging book, a helpful book.

Although it is intended for teachers in elementary schools and for student teachers, it will be of interest and of value as well to high school teachers of science. Those teachers who are concerned about a seeming lack of available science material will be grateful for the numerous simple and inexpensive activities that are discussed, and for the valuable teaching hints that are freely given.

Part I, 91 pages, discusses the teaching of science in general. Part II, 322 pages, is devoted to a study of various science activities that are appropriate for the autumn, winter, and spring seasons. The aims of each project are stated, helpful suggestions are given concerning procedures, and contributing learnings are noted.

This book should challenge and inspire the teachers who make use of it to become more capable, and to their classes more interesting, teachers of science.

H. C. M.

Padre Kino's Feats Of Endurance

Of all the resplendent heroes of the Southwest, in the days when all the colorful grandeur of New Mexico and Arizona was a part of Old Mexico, and Spanish conquistadors and holy men of the Church dared together its savage solitudes, perhaps none is more glamorous than Eusebio Kino, the indomitable Jesuit who gave up the luxury and high social position that belonged to him in Europe to brave a thousand deaths in order to propagate the Catholic faith.

Tumacacori National Monument, Arizona, is rich in memories of the intrepid priest. Historians of the National Park Service, which administers this, as well as 25 other national monuments in the Southwest, have found authentic records attesting to Kino's almost incredible powers of physical endurance. Rising before dawn and riding well on toward midnight, Father Kino's journeys frequently totaled 75 miles of hard riding in a span of 18 or 20 hours, and this over a terrain which even today presents formidable obstacles.

Yet neither fatigue nor pressing errands of mercy prevented the versatile priest from making copious and accurate notes of what he saw along the way. He counted the inhabitants and numbers of dwellings in every Indian village visited, and faithfully kept up official correspondence with his superiors in Church and State. His adventurous spirit led him to explore the most forbidding and trackless desert solitudes and to enter the domain of tribes whose hostility to the white invaders was well known.

All these strenuous activities were carried on under conditions of such privation as to approach martyrdom. His only bed was his cloak and saddle, consisting of two Indian blankets, folded. Even in his last illness Father Kino had no other bed. Today his name, throughout the Missions of the Southwest, is synonymous with consecration, high adventure and unflinching courage.

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Laboratory Periods

(Continued from Page 69)

ever, is recognized by all good teachers to be most unwise, from the standpoint of educational value to the pupil.

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My Science Club

(Continued from Page 72)

the best members. Each meeting should be planned in advance and planned by its members; but you and I must see that it is done. A *planned* program at each meeting will aid greatly in helping a member decide to attend.

There's never any trouble about enthusiasm at the beginning of the year. But did you ever wonder what to do to keep up that enthusiasm? Well, I do. And I think there's only one answer to that problem. I have yet to see any organization of high school students or, for that matter, any successful organization, that will run itself without the leadership and inspiration of some one person. For high school clubs that person, quite generally, is the club adviser. Only rarely is there a student who is both a potential scientist and a leader. Somehow, the combination doesn't often occur. Therefore, it almost always devolves upon the teacher, the club adviser, to furnish the inspiration and guidance and the real "behind-the-scenes" planning that will maintain enthusiasm and promote something which is even more valuable, an urge actually to achieve something worth while.

My club has problems, many of them, but when I am entirely honest with myself I know that the answer to those problems lies within myself. A really good club is one that has a really good adviser. A good adviser is a good teacher, and a really good teacher is one who has patience and understanding; one who will stay in the building until six o'clock and then come back in the evening if necessary; one who knows a great many things and can do a great many things; one who is a natural leader; one who is tactful and entirely human; one who commands the respect and admiration of high school students.

If you and I were all these things and a great many more, perhaps our teaching problems and our science club problems would be reduced to a minimum.

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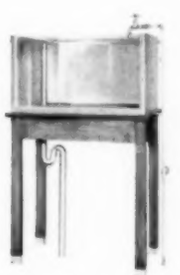

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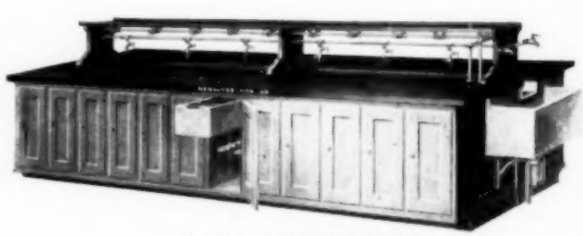

Chemistry Table No. D-794

Electrolytic Solutions

(Continued from Page 78)

of the valence types 1-1, 2-1, 1-2, 3-1, 1-3 and 3-3 and showed that all give straight lines for the plot of activity against ionic strength at high dilution. LaMer later gives similar evidence for other salts[27]. The application of data of various types of salts to the theory shows that the interionic effect is also a function of the dielectric constant and is markedly affected by solvents of low dielectric constant. This has been confirmed by studies in various solvents such as cyclohexane, alcohol, glacial acetic acid, etc.,[28,29,30].

All data, however, are not in agreement with the theory. The value of the constant a' from freezing point data of Randall and Vanselow[31] gives about 0.4 as against the theoretical value of 0.5. The electromotive force data of Nonhebel[32] do not conform to the theoretical value either. Salts of high valence type show discrepancies and give values of a' greater than the theoretical. The values for sulfates are particularly erratic and, in the opinion of LaMer[33], may be explained by incomplete dissociation in the classical sense. To take care of these extreme types, some investigators advocate the use of the extended equation of Gronwald and LaMer[34] but even this does not express the whole truth. Hückel[35] has also extended the theory to take care of the change in dielectric constant with addition of salt. His equation takes the form:

$$-\log f = \frac{0.5\,Z^2\sqrt{\mu}}{1 + 0.327\,a\sqrt{\mu}} + Bm$$

where constant B takes care of specific effect of salt on dielectric constant.

To account for the discrepancies of high valence types and unsymmetrical types, Bjerrum[36] has suggested the idea of ion association in which he uses the converse of the classical theory; that is, that an associated pair is physically identical with an undissociated molecule of the salt. The ions in an associated pair retain their characteristic properties as to color, which is not the case always in a chemically undissociated molecule. Hence, there is a difference of energy content between the associated pair and the undissociated molecule. Bjerrum prefers to speak of the modern theory as that of one hundred per cent ionization rather than complete dissociation.

In the discussion following the presentation of LaMer's address, as reported in the *Transactions of the American Electrochemical Society*, Kahlenberg points out the anomalous behavior of some solutions in water and in other solvents. The rule that a high dielectric constant is the cause of the high conductivity of water solutions does not hold, else why are not solutions of hydrocyanic acid whose dielectric constant is higher than that of water, better conductors. Solutions of HCN are very poor conductors. Epsom salt gives a solution whose freezing point depression and boiling point elevation are the same as a sugar solution, yet it is a conductor. Soap solutions in water conduct well, yet they boil at about the same temperature as pure water; while there is a great rise in the boiling point of an alcoholic soap solution and its conductivity is slight. Hence, he concludes, "the highly selective properties which come into play in the act of solution show clearly that solutions are chemical combinations according to variable proportions. These facts show clearly that there is something fundamentally wrong with Arrhenius' theory and it must be abandoned."

In a critical discussion of the Interionic Attraction Theory, A. A. Noyes[37] shows that the theory can only be expected to be valid for small ions since it was derived on the assumption that the ions were point charges. (This would be the condition required for the application of Coulomb's Law.) Noyes tested the limiting equation for four requirements: (1) that the graph of *log f* against u be a straight line; (2) that the graphs for different substances of the same valence type should coincide; (3) that the graphs for substances of different valence types coincide; (4) that the slope of the graphs must correspond to the value of the constant. He found that the size of the ion had a marked influence even at small concentrations.

DISCUSSION

On reviewing the literature there seems to be a variety of opinions as to the reliability of these two theories. Some believe the Arrhenius theory to be inherently false and feel that it should be dropped completely; others hold it to be still useful when applied to weak electrolytes. It certainly gives a satisfactory explanation of the behavior of weak electrolytes,—one which the elementary student can readily grasp. LaMer[38] is of the opinion that "except for minor corrections which become important only in the concentrated solutions, the ionization theory (of Arrhenius) retains its original form in all essential details when applied to weak electrolytes." If the classical theory is retained for such a case—and it is the opinion of the writer that it should be discarded—the instruction on ionization should not stop with an explanation according to this viewpoint. Neither should the erroneous impression, common to the older editions of many texts, be permitted—that the conductivity ratio gives a measure of the degree of ionization. That is simply teaching something which must later be unlearned.

The distinguishing characteristic of the new theories as opposed to the old, center upon the meaning of the terms "degree of dissociation," and "ionization." Davidson[39] points out the errors involved in applying the Arrhenius theory to strong electrolytes: (1) the conductive ratio Λ/Λ_∞ does not give the true degree of dissociation for it is based on the assumption that the ionic mobilities are constant and this has been proved to be false; and (2) the use of Van't Hoff factor $a = \dfrac{i-1}{n-1}$ where i is the Van't Hoff factor, and n is the number of ions produced by dissociation, is based

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on the assumption that the ions are perfect solutes, which is also false. The occasional agreement for the degree of dissociation is purely fortuitous and never occurs for ions of higher valence types.

All students are familiar with magnets and with the idea of positive and negative charges and their effect on each other. With this device the writer has found it a simple matter to bring out the idea of interionic attraction, even to the student of elementary chemistry. It is a natural outcome of the theory of electronic structure and crystal structure. In an introductory course, a mathematical treatment of the subject of interionic attraction would be entirely out of place. This is too abstruse even for college freshmen; but the fundamental principles underlying the theory are readily grasped. Davidson's suggestions for a simplified approach to the problem of ionization are recommended.

The interionic attraction theory explains why the effect of the strong electrolytic solutes on the properties of the solution are so much smaller than that to be expected if the ions were completely independent of each other. All of the ions are subject to electrical forces which hamper their freedom of motion and reduce their activity. The decrease in equivalent conductivity with increased concentration is caused by a decrease in the speed of migration of ions rather than by a decrease in their number. The charged particles do not move so readily through a medium crowded with particles of opposite charge. Increasing the concentration of the ions means increasing this crowding effect and thus impeding their progress. The magnitude of the charge on the ion also has a marked influence on the rate at which the migration velocity changes.

Kilpatrick[6] brings out another important item to be considered in the teaching of ionization in regard to strong electrolytes and its application to the law of mass action. The law of mass action is derived on the assumption that the free energy change in the system can be truly expressed in terms of concentration and the equilibrium "constant" K is constant only if the ions are perfect solutes. If K is determined for acetic acid in a 0.1M aqueous solution and then in a solution made 0.1M in KCl, the constants are not the same because *the environment has been changed*. The student should be taught that K depends on the temperature, the medium, and the *ionic concentration*. The change of K with ionic concentration, even though the ions are "foreigners", applies to all weak electrolytes.

In the treatment of solubility product, one should also consider this effect of interionic attraction on the value of $K_{s.p.}$ In all calculations the value of $K_{s.p.}$ is usually taken as a constant, and the student is led to believe that a large excess of a precipitating agent is always desirable, while in point of fact, due to the "salt effect", even for a common ion, the result of an excess may reverse conditions. The solubility may decrease at first due to the common ion, and later it may increase due to an increase in ionic concentration. We

should, by all means, teach the solubility product principle, but the constancy of $K_{s.p.}$ should not be overemphasized. It would be more enlightening to calculate the change in the value of $K_{s.p.}$ with a change in the ionic concentration from solubility data, rather than to perform unduly detailed calculations assuming a constant $K_{s.p.}$

The hypothesis of complete dissociation from strong electrolytes has not been proved experimentally in all cases. From a study of activity coefficients of thallous salts, Robinson[11] finds it necessary to adopt the hypothesis of incomplete dissociation to account for the nonconformity of the activity coefficients of the nitrate with the limiting law and with the Gronwald-LaMer-Sandver extended equation. This hypothesis of incomplete dissociation has been resorted to quite frequently, particularly in the case of nitrates[42-43]. A study of the Raman spectrum has been resorted to in some of these cases[44], and no lines were present which could be ascribed to the undissociated molecule. It is doubtful, however, whether evidence from Raman spectra is conclusive, for Woodward[45] has shown that hydrofluoric acid, which certainly is incompletely dissociated, gives no Raman line for the undissociated molecule.

The accumulation of recent data and the attempts to make them fall in line with either the simple limiting law or the extended theory, point to a certain average conformity which would indicate that we are on the right track. The consistent discrepancies, however, in the case of all the more complex types of electrolytes and the various solvents, would indicate also that there is much to be revealed before the behavior of electrolytes will be completely explained.

BIBLIOGRAPHY

1. *J. C. S. 105*, 1414 (1914).
2. *Z. Physik. Chem.* 1, 631 (1887).
3. LaMer, *Trans. Am. Electro-chem. Soc.* 507, (1927).
4. Pickering, *Report of British Assoc. for Adv. of Sc. 60*, 318 (1890).
5. Rudolphi, *Z. Physik. Chem. 17*, 385 (1895).
6. Van't Hoff, *ibid., 18*, 300 (1895).
7. Storch, *ibid., 19*, 13 (1896).
8. Kraus and Bray, *J. Am. Chem. Soc. 35*, 1314 (1913).
9. Noyes and Sammet, *J. Am. Chem. Soc. 24*, 944 (1902).
10. Noyes and Kato, *ibid., 30*, 318 (1908).
11. Van Laar, *Archives Musee Teyler*, Series II, 7, 59 (1900).
12. Sutherland, *Phil. Mag.* (6), *14*, 1 (1907)
13. Bjerrum, *Kgl. Danske Videnskab. Selskabs Skrifter* (7), *4*, 1 (1906).
14. Noyes, *Science 20*, 584 (1904).
15. Milner, *Phil. Mag.* (6), *23*, 551 (1912).
16. Braggs., *X-Rays and Crystal Structure*., London and N. Y. 4th ed.
17. Lewis & Randall, *Thermodynamics*, McGraw-Hill, 1924.
18. Lewis and Randall *J. Am. Chem. Soc. 43*, 1141 (1921).
19. LaMer, *Transactions of Electrochem. Soc.* April, 1927.
20. Milner, *Phil. Mag.* (6) *25*, 742 (1913).
21. Ghosh, *J. Chem. Soc. 113*, 1918; *117* (1920).
22. Debye and Huckel, *Physik. Zeit. 24*, 185 (1923).
23. Scatchard, *Chem. Rev. 13*, 10 (1933).
24. Onsager, *Physik. Zeit. 28*, 277 (1927)
25. Davies, *Conductivity of Solutions*, 2nd edition.
26. Bronsted and LaMer, *J. Am. Chem. Soc. 46*, 555 (1924).
27. LaMer, King & Mason, *J. Am. Chem. Soc. 49*, 313 (1927).
28. Noyes and Baxter, *ibid., 47*, 2122 (1925).
29. Webb, *ibid., 48*, 2263 (1926).
30. Baxter, *ibid., 48*, 615 (1926).
31. Randall and Vaselow, *J. Am. Chem. Soc. 46*, 2418 (1924).
32. Nonhebel, *Phil. Mag.* (7), *2*, 1085 (1926).
33. LaMer, *Trans. Faraday Soc.* April, 1927.

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34. Gronwald, LaMer and Sandved, *Physik Zeit.* 29, 358 (1928).
LaMer, Gronwald and Greiff, *J. Physical Chem.* 35, 2245 (1931).
35. Huckel, *Physik. Zeit.*, 26, 93 (1925).
36. Bjerrum, *Det. Kgl. Danske Vidensk. Math-fysisk Medd.* VII, 9, (1926).
37. Noyes, *J. Am. Chem. Soc.* 46, 1080, 1098 (1924).
38. LaMer, *Trans. Am. Electrochem. Soc.* April, 1927.
39. Davidson, *J. Chem. Ed.* 12, 24 (1935).
40. Kilpatrick, *J. Chem. Ed.* 9, 840 (1932).
41. Robinson, *J. Am. Chem. Soc.* 59, 84 (1937).
42. Onsager, *Physik. Zeit.*, 33, 22 (1932).
43. Cowperthwaite, LaMer and Barksdale, *J. Am. Chem. Soc.* 56, 544 (1934).
44. Rao: *Proc. Roy. Soc.* (London) L44, 150 (1934).
45. Woodward, *Physik. Zeit.*, 32, 777 (1931).

General References

Harned—*Taylor's Treatise on Physical Chemistry*, 2nd ed. Vol. I, Van Nostrand.
Davies—*Conductivity of Solutions*, 2nd edition, J. Wiley and Sons.
Symposium on Electrolytes—*Trans. Faraday Soc.* April, 1927.
Symposium on Electrolytes—*Chem. Reviews*, Vol. XIII, 1933.
LaMer—Recent Advances in Ionization Theory as Applied to Strong Electrolytes. *Trans. Am. Electrochem. Soc.* April, 1927.

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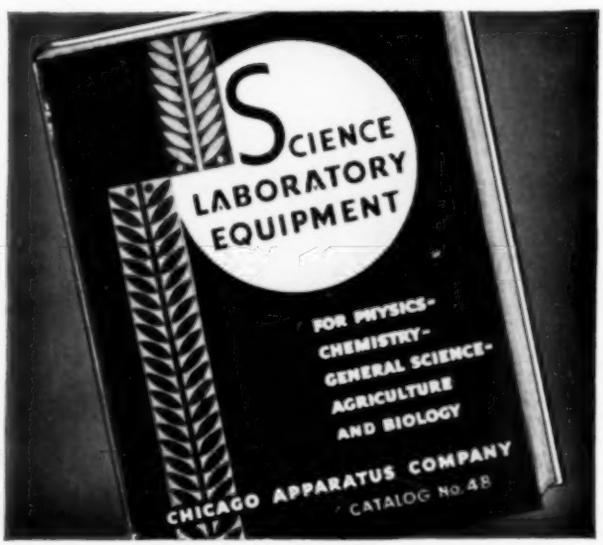

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Scholastic Classification

(Continued from Page 75)

second intentions, the science by which the mind places order in its own actions. It is, too, a distinct science, because it has a distinct formal object, a distinct point of view.

Once again, I can take these same actions, my actions, and consider them not as to how I produce them, nor yet, as to how they are coordinated, but solely and simply in their relation to a rule of right and wrong. This is an entirely new viewpoint, a new formal object, and hence, a new science, which constitutes the branch of knowledge called *ethics*.

This, then, is the Aristotelian classification of the sciences: physics, mathematics, metaphysics, logic, and ethics. And the Schoolmen went a step further and showed that there exists an interdependence among these five.

Subordination of sciences means simply the dependence of one science on another. The term is taken in a broad and in a restricted, or proper sense. Strictly speaking, among the five fundamental sciences mentioned above, there is no real dependence. None of them can be considered as a *genus*, of which the other is a *species*. Each of them can and does fulfill the essential notes of a science without being united to the other. The same, however, cannot be said, let us say, of music and mathematics, or of perspective and mathematics. But I can be a physicist without being a logician; I can be a metaphysician without the science of ethics.

If, however, there be a question of a subordination in a more general acceptation, a subordination that implies *some kind* of dependence, then sciences can be diversely subordinated either to logic, metaphysics or ethics.

For since logic is the science of correct thinking, the science of placing order in our mental operations

and thus of finding truth, it is the leader and the mistress of all sciences. From a different standpoint and for different reasons, all the sciences depend on metaphysics. First, because they all treat of *being* in some way or another, and *being* itself is the material object of metaphysics. Secondly, because all knowledge presupposes certain principles without which not even one step can be taken on the road of science. Take, for example, the self-evident statement that a thing cannot exist and not exist at the same time. That is a metaphysical principle. Finally, science, like everything human, is teleological, it has a finality. Whatever it does, it does for a definite end, its ultimate goal and destiny. *Ethics* treats of the ultimate end of human action. Therefore science depends on it. Over and above this, there is a qualified dependence of the sciences consisting in this, that one aids the other, that one advocates the other, that one borrows principles from the other, although each remains essentially independent. Thus for instance, modern physics uses mathematics as an auxiliary, without, on that account, ceasing to be independent.

Such, then, are the general traditional lines, along which the sciences are classified, divided and interrelated.

◆

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Neutron Rays Harmful

The neutron rays, produced by the powerful atom smashing machines and radioactive bombardments in research laboratories, are dangerous to experimenters. This is the conclusion reached by investigators after experimenting on the effect of these rays on white rats. The rats were killed by exposure to the rays. Neutrons are uncharged particles of matter which can be ejected from the cores of atoms by bombardment with high voltage sources.

◆

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A newly discovered and synthetically produced plant hormone, "heteroauxin," has been isolated in quantity by botanists at the University of Iowa. Applied to a variety of plants this hormone produced amazing results such as: the growth of roots from a lily petal; quick maturing of peas planted in heteroauxin-treated soil; and extraordinary hardihood in delicate "wax" plants. Pea seeds planted in soil treated with this hormone sprouted no more rapidly than seeds in untreated soil, but the development after sprouting was three times more rapid where heteroauxin had been mixed with the soil.

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Science For Teachers

(Continued from Page 71)

elementary school pupils should be explored. Those areas of science likely to be most interesting to young children should be emphasized, such as: birds, flowers, trees, animals and insects, rocks, land forms, constellations, magnetism, and electricity. The purpose of these experiences should be to make the teacher intelligently aware of the possibilities in the environment, and to aid her in utilizing these environmental resources in accordance with the interests and needs of children.

SCIENCE IN THE INTEGRATED CURRICULUM COURSE

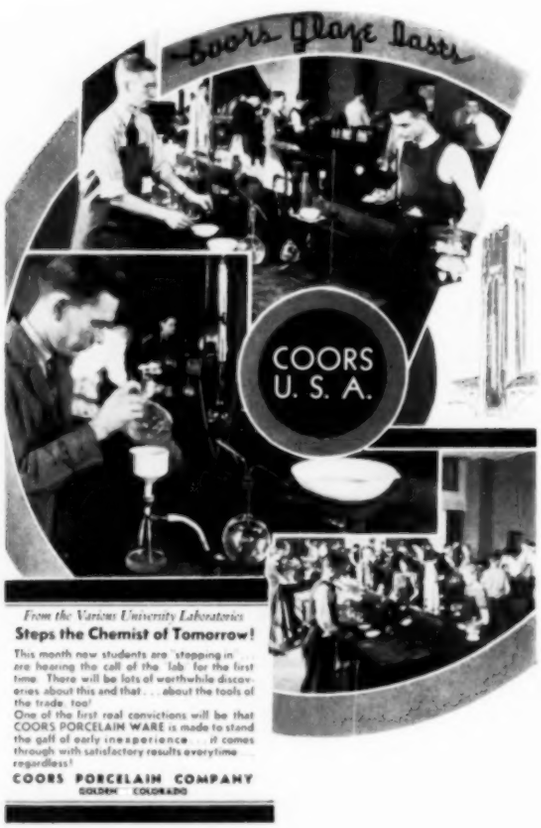
If teachers are to see the implications of science in the integrative areas of experience in terms of which the modern elementary school curriculum is being built, members of the science faculty should cooperate in the basic curriculum course for prospective teachers. Experts from different science fields should show the enrichment each field offers to the integrating center of interest.

Those most interested in the extension of science education are making no plea for the introduction of science as "another subject" in the elementary school curriculum. Rather do they recognize science as a necessary and integral part of all social situations. Social studies devoid of science implications are incomplete. Understanding and appreciation of these important relationships, which are more important in fact than the discrete learnings in any single field, can only be achieved as the specialists in the different content fields work together. Young teachers cannot be expected to discover these relationships for themselves or become aware of their importance except as the experiences of the professional training program are directed toward this end.

To build a proper and continuous program of education for the establishment of scientific concepts and attitudes demands the solution of many important problems in the field of methods, materials, and teacher education. The outcomes of early education in sciences are not to be measured by an increasing number of scientists and naturalists in our population, but rather in terms of an increasing number of competent individuals who can interpret the contribution science has to make to the health, safety, and welfare of human beings and who have acquired scientific methods in making a constructive attack on the problems of social living.

REFERENCES

1. *Suggested Course of Study in Science for Elementary Schools.* Sacramento: California State Department of Education Bulletin No. 13, Part I, July 1, 1932.
2. *Science Guide for Elementary Schools.* Sacramento: California State Department of Education. 1934-1937. Volume I. No. 1, *Suggestions to Teachers for the Science Program.* No. 2, *Pets and Their Care.* No. 3, *Common Insects.* No. 4, *Sky Study.* No. 5, *Weather.* No. 6, *Frogs, Toads, and*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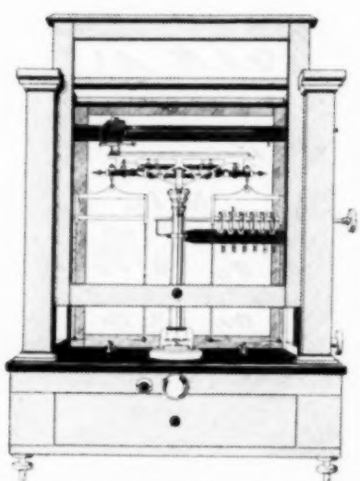

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[3] Formulation supplied to Dr. Vesta Holt, Head, Department of Biological Sciences, Chico State College, Chico, California.

◆

The Catholic High School

(Continued from Page 68)

So far as our high school students are concerned, the staff can at least do its level best to keep alive in them the spirit of scientific curiosity and inquiry. A Frenchman has said that "man is born a metaphysician." He might have added, "and also a research scientist." The average child may be defined as a bundle of questions. This is the spirit of curiosity and inquiry that can be developed, if there be wisdom and insight on the part of teachers, into curiosity and inquiry of the scientific order.

High school students are hardly mature enough in mind or sufficiently equipped with knowledge and training to carry on real research. It only confuses the issue to dub as research the adolescent digging and experimenting that accompany the best type of high school teaching and learning. But even so, there are numerous very simple and minor problems of investigation which can be proposed to the more gifted high school student and which, if not requiring research proper for their solution, at least require something close to it. A bit of backyard research, and it may literally be called that, has recently brought us the fact, new, I believe, to ornithology, that the house wren, who was formerly looked upon as a model of monogamous fidelity, is really much less of a model than he was thought to be. In fact he is very apt to go close to Mahomet's legal limit of four spouses.

There are hundreds of minute problems of investigation of this kind that can be set to the high school student. And even where problems are not problems of even such minor technical research, they require original investigation by him and keep alive in him the spirit of inquiry and of original first-hand investigation, original at least so far as the particular high school student is concerned.

Could we not also do more than we are doing to encourage some of our more gifted students to prepare for research careers? It may be suggested to them that there are other professions besides those of medicine, law, engineering, and teaching. Or they may be encouraged to enter these professions with research aims in view. There is no royal road to vocational success. But if a student is above the average and shows promise, at least his attention may be called to the vocational opportunities in scientific research.

What of the staff? Can we fairly expect productive research on the part of the members of the high school staff? Certainly we cannot fairly expect such from all. But on practically all high school staffs there are certain teachers who have a genuine interest in research and who would like to be free to do it. Are there no possibilities here? Quantity in production can and should hardly be aimed at. Could not however high quality of research on their part, even though the problems under investigation be minor ones, be suggested as more than making up for quantity? In many cases, too, such staff research can be carried out jointly with the students. Some high school teachers steal time to devote a modicum at least of their energies to research problems in which they are interested. But they make ample restitution for their theft, both to their school and to their students, by their more live and dynamic teaching.

◆

Some Facts About Artifacts

An artifact is defined in the dictionary as "a product of human workmanship, applied specially to the smaller products of the aboriginal arts as distinguished from natural objects."

Study of artifacts enables archeologists to arrive at information relative to the people who made them; the approximate date of their occupancy of the location; their state of progress; their tribal customs, and religious rites.

At Acadia National Park, Maine, for example, the artifacts displayed in the Abbe Museum tell the story of a prehistoric race of Indians who fished along the surf-beaten cliffs and hunted on the mountain slopes, fragrant then, no doubt, as now with balsam firs and pines, long before the day when Samuel de Champlain first sighted the shores of the island of Mount Desert. The ancient burials of these vanished people when excavated disclose the things they prized as treasures, worthy to be taken to the next world; stone pendants, shell beads, both worn as ornaments; "Indian red" clay, long ago scattered over their mouldering bones, as the original containers of hide or basketry disintegrated. In the land to which he was going the dead warrior might have need of war paint, according to the beliefs of his tribe. Thus the little pile of red-brown dust testified to the faith in a hereafter in the soul of the long-departed aborigine. Similarly, the crude ornaments of stone and shell connote a love of beauty that expressed itself in personal adornment.

Reminders . . .

You know what you are to teach. Plan *how* to do it, not merely *what* to do.

•

The habits of students are formed during the first week of school.

•

When students do not study, it may be because they have not been trained properly.

•

Your class should learn at once that assigned work must be completed. The responsibility is the teacher's. Talking alone will not do it.

•

Teach from the board, not from a book This is especially important when presenting new theoretical materal.

•

Be sure that your assignments are definite, and that your teaching has made it possible for the student to get the lesson. Sometimes a student doesn't do his work because he can't do it, not because he wont.

•

The teacher who sits down too much may not be doing a good job.

•

Study periods should be *study periods.*

•

Watch especially the first ten minutes and the last ten minutes of the hour.

•

Students should be trained in every-day courtesies such as moving quietly, answering courteously, and standing when spoken to.

•

Don't neglect fire drill

Important Discoveries

(Continued from Page 80)

and their response to different colors of lights noted. The males responded in greater number and more rapidly than the females.

The flies having sepia eyes were more strongly and more consistently attracted to the colors than those with other eye colors. Brown-eyed flies were next in sensitiveness, while white-eyed flies showed least interest in the colored lights.

Professor Fardon's purpose in studying the response of flies to color is to determine how such genetic traits as eye color are handed on from generation to generation.

◆

"The Looker-up to Heaven"

"The Looker-up to Heaven" was the name bestowed by the Onondaga Indians upon Father Pierre Millet, whose name is perpetuated at Father Millet Cross, located on the Fort Niagara Military Reservation, New York.

This celebrated Jesuit missionary labored for some 15 years among the Onondagas and Oneidas, suffering hardships and at times cruelties and the menace of death by torture while so engaged. His services were invoked by the garrison at Fort Niagara, decimated by disease, and it was while responding to their sufferings that the cross 18 feet high, was erected within the fort by its officers. Father Millet blessed it on Good Friday, April 16, 1688. Although the original cross long ago disappeared, it has been reproduced by one of bronze, 18 feet high, which honors not only the devotion of Father Millet but those other priests who left the security and comparative ease of their European homes to face privation, peril, and, frequently, martyrdom, in order to bring the faith to the "heathen savages."

◆

Infra-Red Microscope

A new kind of microscope has been developed by Dr. Zworykin of the Radio Corporation of America. This instrument utilizes the infra-red rays emitted or reflected from microscopic specimens. The infra-red rays strike a sensitive metal plate and cause electrons to be emitted. These electrons then pass through an "electron lens" system which brings them to a focus on a fluorescent screen, making the object visible.

It is predicted that this new instrument will find many uses in the field of science and especially in biology. Small organisms, ordinarily killed or injured when exposed to visible or ultra-violet light, can now be studied by irradiation with the non-destructive infra-red rays. This principle can also be applied to astronomical telescopes and other optical instruments.

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